United States Patent [19]

Belter

[11] **Patent Number: 4,660,907**

[45] **Date of Patent: Apr. 28, 1987**

[54] **EMI FILTER CONNECTOR BLOCK**

[75] Inventor: **Robert E. Belter**, Carlsbad, Calif.

[73] Assignee: **Kyocera International, Inc.**, San Diego, Calif.

[21] Appl. No.: **746,744**

[22] Filed: **Jun. 20, 1985**

[51] **Int. Cl.**[4] **H01R 13/66**

[52] **U.S. Cl.** ..... **339/14 R**; 339/147 R

[58] **Field of Search** ..... 339/14 R, 143 R, 147 R, 339/147 P; 333/182, 183

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,973,490	2/1961	Schlicke	333/182
4,126,370	11/1978	Nijman	333/183
4,212,510	7/1980	Ritchie et al.	339/147 R

Primary Examiner—John McQuade

Attorney, Agent, or Firm—Spensley Horn Jubas & Lubitz

[57] **ABSTRACT**

A multiple pin connector comprising a pin-support body, a filter block, a ground plane, and a dielectric retainer block, through which a plurality of pin contacts extend in a parallel, space the part alignment for engaging complementarily positioned contacts on meeting conductors. The ground plane includes flanges extending around opposed edges of the filter block. The filter block is formed to have a recess therein adjacent each pin location and extending therefrom to an edge of the filter block proximate to the flange of the ground plane. A chip capacitors having a capacitance value appropriate to a desired level of electromagnetic interference protection is inserted in each recess of the filter block. Electrical connections are maintained between the pin contacts and the individual chip capacitors, and the individual chip capacitors and the flanges of the ground plane, by means of solder bridges appropriately disposed. Alternatively, the chip capacitors may be individually soldered to eyelets through which the pins may be placed. In a further embodiment, the flange of the ground plane is utilized as a spring member to retain the chip capacitor within the recess and maintain a electrical contact of the chip capacitor to the pin or eyelet. Each individual chip capacitor may be readily removed and replaced, individually, to vary the degree of electromagnetic interference protection or to replace a faulty chip capacitor.

9 Claims, 7 Drawing Figures

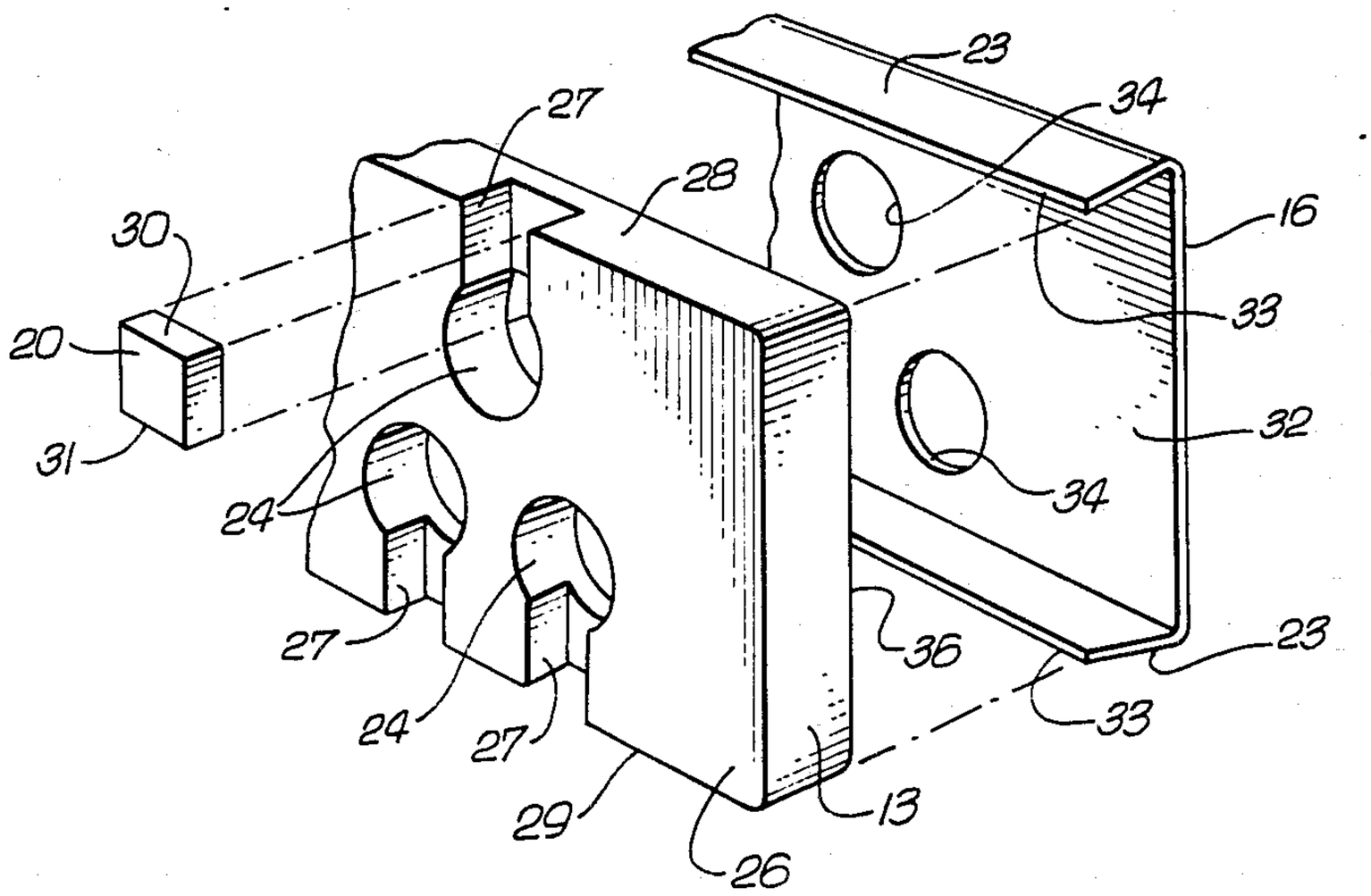


Fig. 1

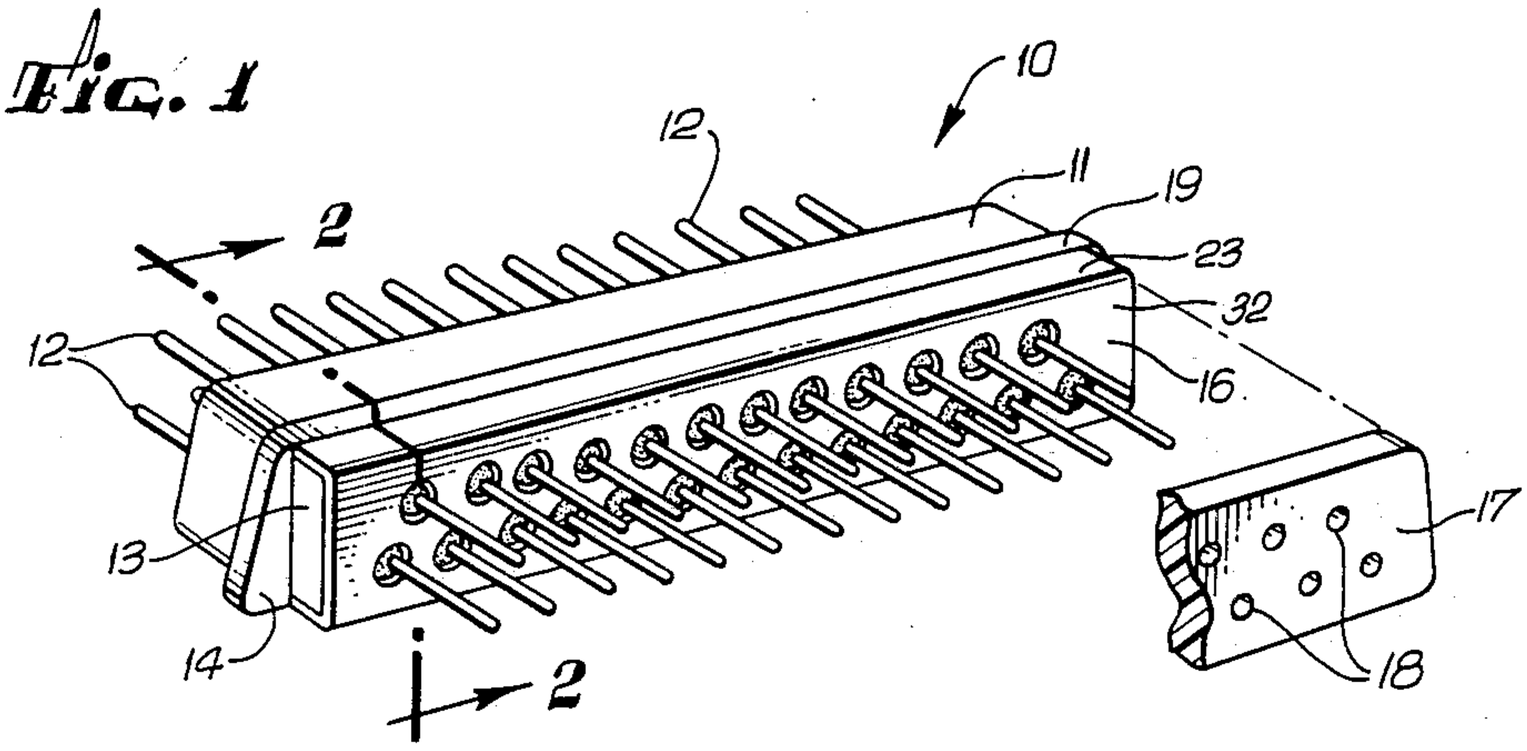


Fig. 2

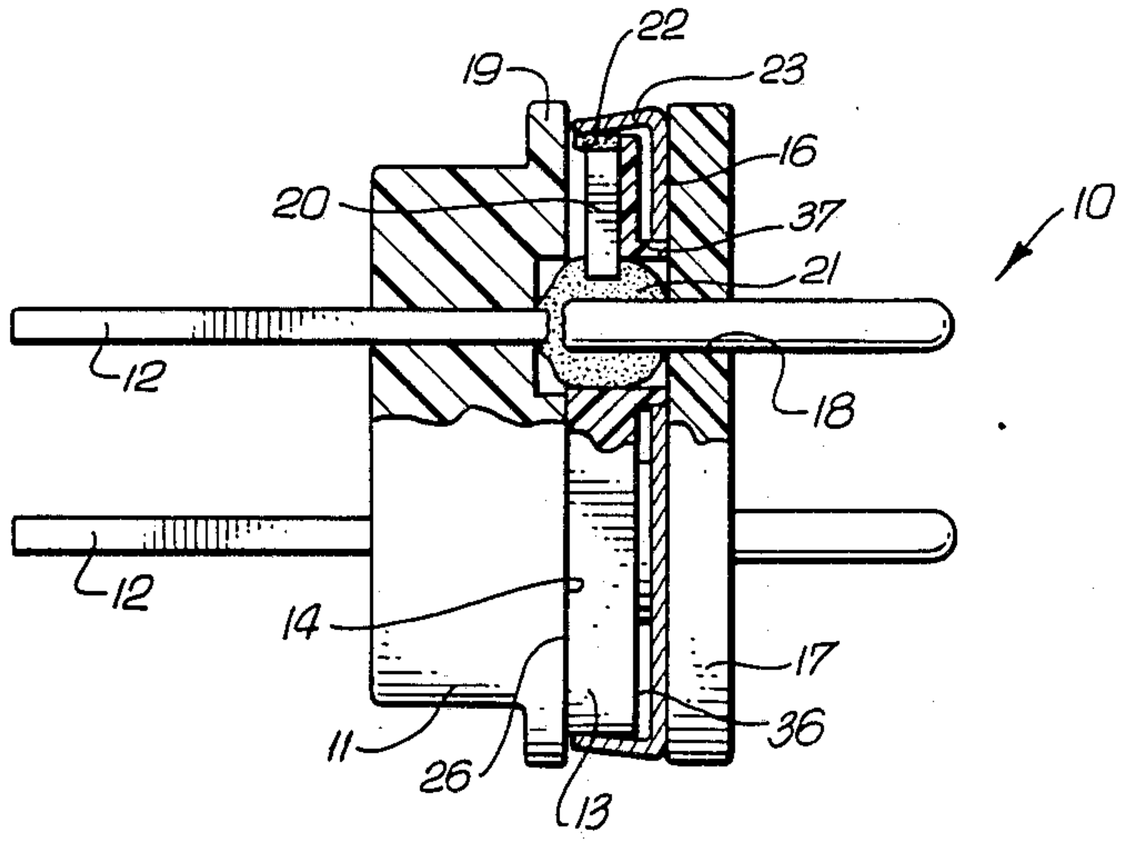


Fig. 3

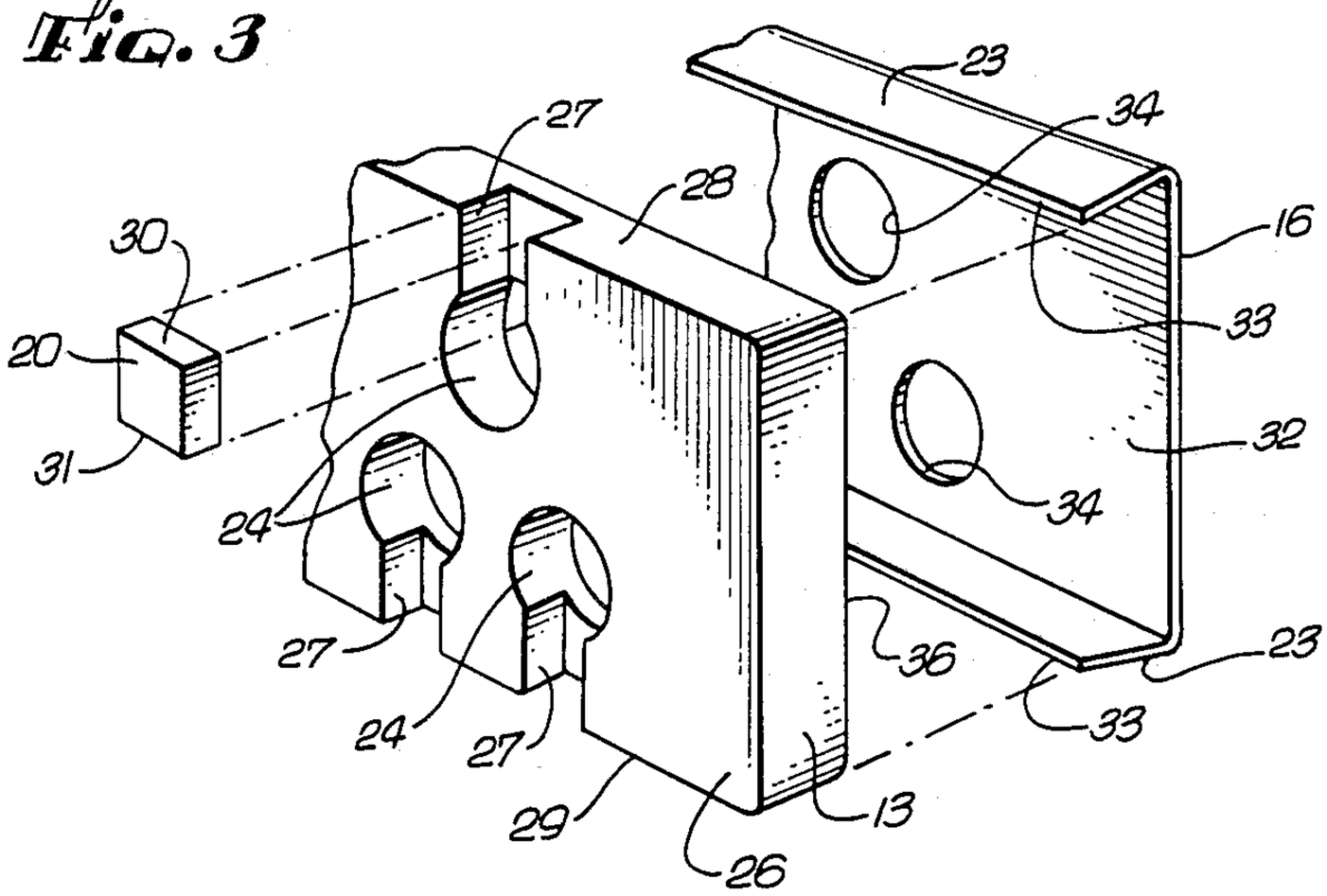


Fig. 4

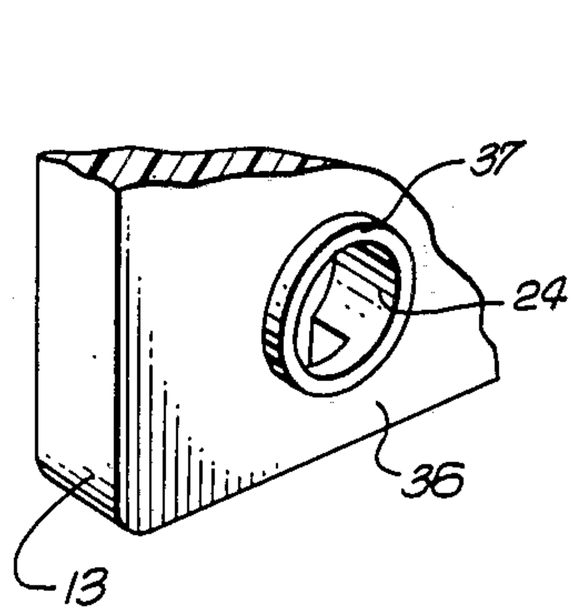


Fig. 5

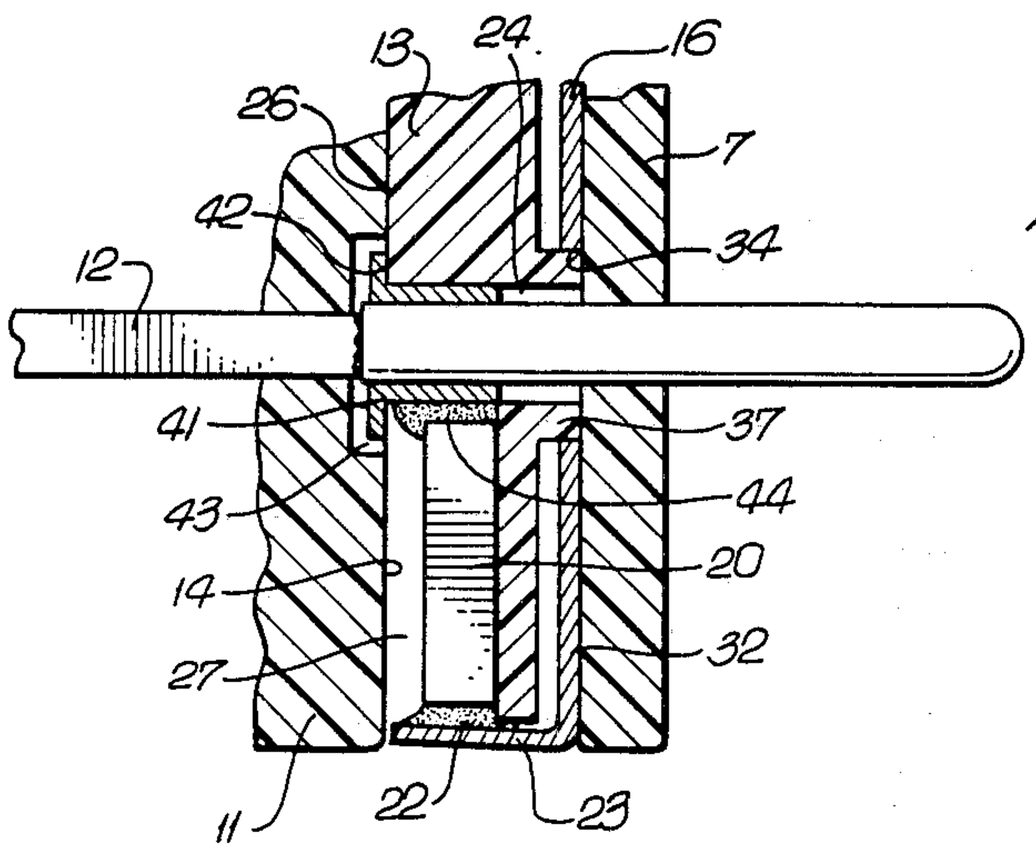


Fig. 6

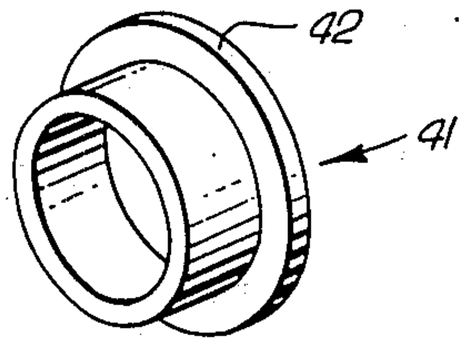
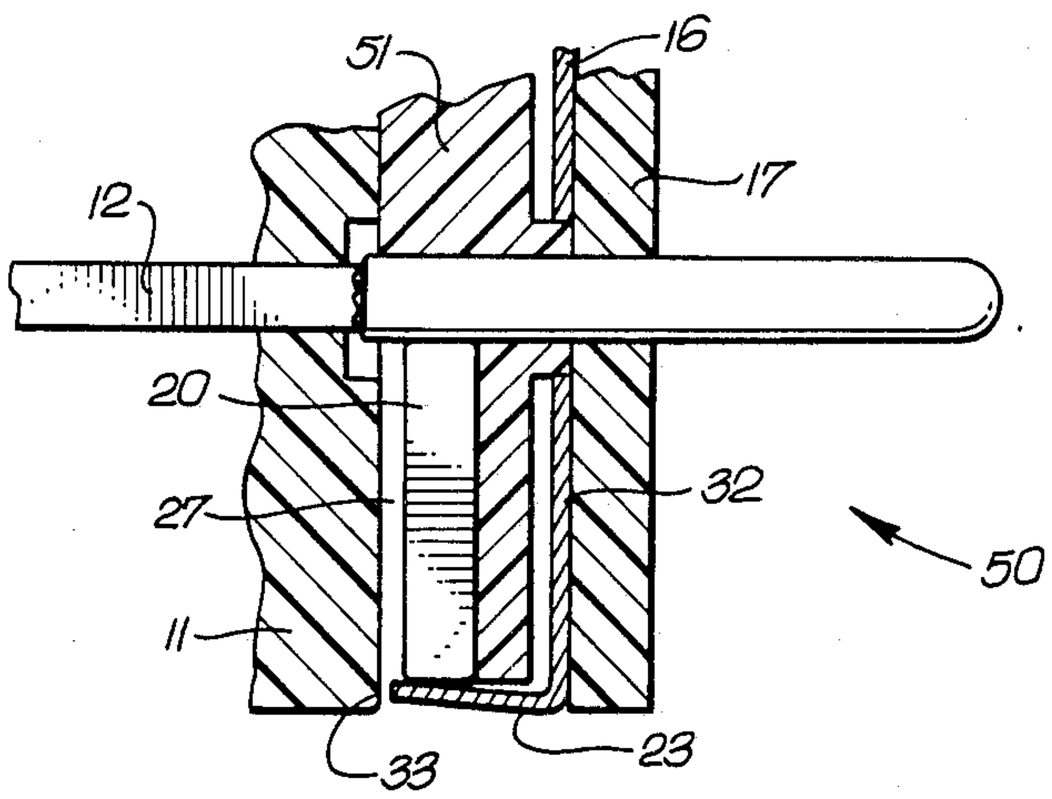


Fig. 7



EMI FILTER CONNECTOR BLOCK

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates generally to electrical connector assemblies and, more particularly, to connector assemblies providing filtering to minimize electro-magnetic interferences.

2. Description of Related Art

In numerous applications, such as in the computer field, long, unshielded cable runs are often susceptible to picking up extraneous signals where they enter a shielded housing. Filters for such connectors, typically located at the interface through which such cables enter such housings, are known in the art and typically utilize the connector shell for a ground return and include capacitor filters connected between the connector and the connector shell. Typical among the known types of connector filter assemblies are those shown in U.S. Pat. Nos. 3,546,638 to Park, 3,961,295 to Hollyday, et al., 4,079,343 to Nijman, 4,187,481 to Boutros, and 4,222,626 to Hollyday, et al. Each of these patents teaches the construction of a filter which completely surrounds each pin of the connector. Typically, these filters are formed as a sandwich of plate elements separated by a dielectric member. As may be seen by a review of these patents, each of the constructions is relatively complex.

U.S. Pat. No. 3,538,464 to Walsh teaches a similar interference filter construction. However, Walsh discloses a multiple pin connecter wherein the conductive plates and the dielectric plate members are formed as sheets having a plurality of conductive and nonconductive areas, each provided with an interior hole through which the contact pin of the connector is passed. Appropriate contact is made between the pin and the interior surface of alternate conducting layers, with the exterior surface of the interleaved layers placed in electrical contact with the conductor shell. A further variation on this stacked, multiple pin connector approach is found in U.S. Pat. No. 4,144,509 to Boutros.

In addition to the complexity of design of the above-listed patents, if one of the pins of a multiple pin connector is found to have a faulty interference filter, significant effort is generally required to disassemble such a multiple pin connector in order to repair the faulty capacitor. Often the labor intensive costs associated with affecting such repairs have prompted users of such multiple pin filtered connectors to discard the entire connector and replace it with a new, fault-free multiple pin connector.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a multiple pin connector which provides a significant amount of electro-magnetic interference protection together with minimal cross talk between connector pins.

It is another object of this invention to provide a multiple pin connector having significant surge protection.

A further object of this invention is to provide a multiple pin filter connector wherein the filter elements associated with each pin of the connector are individually replacable.

Yet another object of the present invention is to provide a multiple pin filter connector having minimal size and significantly reduced fabrication cost.

These objects are obtained by providing a connector body, formed of a dielectric material, having a plurality of holes therein through which a like plurality of connector pins may be inserted. A second dielectric plate, having a like plurality of holes similarly distributed, is formed to have a like plurality of recesses, each adapted to receive a chip capacitor similar to those well known in the art. Each of the chip receiving recesses is formed such that one end of a chip therewithin is in proximity to a pin passing through its associated feed-through hole, while the other end of the chip is in proximity to a ground plane electrically communicating with each such chip. An additional dielectric plate, having a like plurality of feed-through holes appropriately distributed, is placed over the connector pins such that the chip bearing dielectric plate and the ground plane are sandwiched against the dielectric connector body. A conductive connector shell may be included to surround the periphery of the connector such that the conductive shell is in electrical contact with the ground plane. Alternatively, one of the feed-through connector pins may be utilized in direct contact with the ground plane as a ground connection. The chip capacitors may be retained in their recesses by soldering one end of the chip to the connector pin and the other end of the chip to the ground plane, or, alternatively, by soldering one end of the chip to an eyelet accepting the feedthrough connector pin and the other end of the chip to the ground plane, or, alternatively, by retaining the chip in contact with both the pin and the ground plane by a spring action of a flange formed on the ground plane.

As may readily be observed from the detailed description of the perferred and alternate embodiments set forth below, a multiple pin connector in accordance with the present invention may be readily disassembled by removing the connector shell, enabling the connector body and the dielectric cover plate to be separated, providing access to each of the ceramic chips which may be readily unsoldered or removed from their respective spring mounting positions and replaced.

The foregoing and other objects, features and advantages will be apparent from the following more particular description of a preferred and alternate embodiments hereof, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIG. **1** is a perspective, partially fragmented view of a multi-pin connector in accordance with the present invention;

FIG. **2** is a cross-sectional view through the multi-pin connector taken through section **2—2** of FIG. **1**;

FIG. **3** is an exploded fragmentary perspective of a ground plane and capacitor retaining element in accordance with the present invention;

FIG. **4** is a fragmentary perspective of a reverse side of the capacitor retaining element of FIG. **3**;

FIG. **5** is a fragmentary cross-section of a second embodiment of a multi-pin connector in accordance with the present invention;

FIG. **6** is a perspective of an eyelet utilized in the embodiment of FIG. **5**;

FIG. **7** is a fragmentary cross-section of a third embodiment of a multi-pin connector in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. **1**, a typical mutliple-pin connector is indicated generally at **10**. When fabricated in accordance with the present invention, the multiple-pin connector **10** is comprised of a pin-support body **11**, formed of dielectric material, through which a plurality of conductor pins **12** having their longitudinal axes substantially in alignment may be inserted, a filter block **13**, having a plurality of holes there through distributed in a pattern corresponding to the placement of pins **12**, abutted against a first surface **14** of the pin-support body **11**, a ground plane **16**, also having a plurality of holes distributed to enable the pins **12** to pass therethrough without electrical contact, and a dielectric retaining block **17**, formed to have a plurality of holes **18** therethrough aligned with and frictionally accepting the pins **12**. The dielectric retaining block **17** may be retained to the pins support body **11** by a metalic shell (not shown) around the periphery formed by a flange **19**, or alternatively, the dielectric retaining block **17** may be formed to have extensions (not shown) which may be mechanically coupled to the flange **19** of the pin-support body **11**.

Referring next to FIG. **2**, each of the pins **12** passing through the pin-support body **11**, the filter block **13**, the ground plane **16** and the dielectric retaining block **17** has a chip capacitor element **20** associated therewith. As will be discussed more fully below, the chip capacitors **20** are situated within cavities formed in the filter block **13**. One electrical terminal of each chip capacitor **20** is coupled to a respective one of the pins **12** by a soldering bead **21**. The other electrical terminal of each chip capacitor **20** is coupled by a soldering bead **22** to a flange **23** formed on the ground plane **16**.

Assembly of the multiple pin connector **10** may be accomplished by inserting the appropriate number of pins **12** through the holes of the pin-support body **11**, the filter block **13** and the ground plane **16**. The pin-support body **11** may then be moved leftwardly in FIG. **2** with respect to the filter block **13** so that the filter chip capacitors **20** may be inserted in their cavities within the filter block **13** and so that the soldering beads **21** and **22** may be formed. When all such chip capacitors **20** have been soldered, the pin-support body **11** may be moved rightwardly, according to FIG. **2**, to abut the filter block **13**, and the dielectric retaining block **17** may be placed over the rightward ends of the pins **12** and then slid leftwardly in FIG. **2** to abut against the ground plane **16**.

Referring next to FIG. **3**, the filter block **13** may be observed to have a plurality of holes **24** formed therethrough from a surface **26** which abuts the first surface **14** of the pin-support body **11** when the multiple pin connector **10** is assembled. Each of the holes **24** has a recess **27** formed in the surface **26** so as to extend from the hole **24** to an edge **28**, **29** of the filter block **13**. Each of the recesses **27** is adapted to accept and enclose a chip capacitor **20** of a type readily commercially available. Such chip capacitors **20** are typically fabricated to have a substantially planar rectangular form, with a pair of electrical terminals **30**, **31** disposed along opposing edges of the rectangle. When the chip capacitor **20** is installed in the recess **27** during assembly, it is oriented so that the electrical terminals **30** and **31** are proximate to the edges **28**, **29** and the hole **24**, respectively.

The ground plane **16**, formed of a conductive material, is shaped into a channel having a pair of flanges **23** extending linearly substantially the length of the filter block **13**. The dimension of each flange **23** from a web surface **32** of the ground plane to a free edge **33** of the flange **23** is substantially equal to the thickness of the filter block **13** taken in a direction of the axial extent of the pins **12**. A plurality of holes **34** are formed through the web surface **32** of the ground plane **16** in a pattern matching the placement of the holes **24** through the filter block **13**. Each of the holes **34** has a diameter greater than the diameter of the holes **24**.

Referring next to FIG. **4**, there is illustrated a portion of the filter block **13**, showing primarily a portion of an obverse surface **36**, opposed to the aforementioned surface **26**, encompassing one of the holes **24**. During fabrication of the filter block **13**, the surface **36** is formed to include a flange **37** surrounding each of the holes **24**. The flange **37** is formed as a right circular angular cylinder having an inner diameter equal to that of the hole **24** and an outer diameter substantially equivalent to, but less than, the diameter of the hole **34** through the ground plane **16** such that, when assembled, the flange **37** extends through the hole **34** of the ground plane **16**, thereby precluding direct electrical contact between a pin **12** passing through the hole **24** and the ground plane **16**.

Referring next to FIGS. **1** through **4**, inclusive, it may be seen that an appropriate selection of the capacitance value associated with each of the chip capacitors **20**, during assembly of the multiple pin connector **10**, can provide the desired measure of protection against externally caused electromagnetic interference. Moreover, it may be noted that the degree of protection against electromagnetic intereferences afforded to each of the pins **12** may be varied among the several pins **12** by selecting chip capacitors **20** having differing values of capacitance. In each case, it should be noted that the individual chip capacitors **20** may be individually replaced in the event that a particular pin **12** is determined to require a greater or lesser degree of protection against electromagnetic interferences, or in the case where the individual chip capacitor **20** has been determined to be faulty.

Referring next to FIG. **5**, a fragmentary cross-sectional portion of a first alternate embodiment of a multiple pin connector in accordance with the present invention is indicated generally at **40**. In common with the preferred embodiment described above, the multiple pin connector **40**, when assembled, provides for a plurality of pins **12** passing through holes formed in a pin-support body **11**, a filter block **13**, a ground plane **16**, and a dielectric retaining block **17**. However, in contrast to the preferred embodiment, the multiple pin connector **40** includes an eyelet **41**, formed of a conductive material as a substantially right circular angular cylinder, having an outer diameter substantially equivalent to the inner diameter of the hole **24** formed through the filter block **13** and an inner diameter frictionally matching the diameter of the pin **12**. The axial extent of the eyelet **41** should be sufficient to extend from the surface **26** of the filter block **13** in assembled contact with the pin-support body **11** to beyond the depth of the recess **27** holding a chip capacitor **20**, without reaching or contacting the ground plane **16**. A flange **42** may be formed on one end of the cylinder forming the eyelet **41** such that the eyelet **41** may be properly positioned, during assembly within the hole **24** through the filter block **13** by abut-

ting the flange **42** against the surface **26** of the filter block **13**. A cavity **43** may be formed in the first surface **14** of the pin-support body **11** at the placement position of each of the pins **12**, said cavity **43** accepting the flange **42** of the eyelet **41**. Further detail of the construction of the eyelet **41** may be observed by reference to FIG. **6**.

Each of the pins **12** in the multiple pin connector **40** has a chip capacitor **20** associated therewith. Each chip capacitor **20** is placed within its respective recess **27** within the filter block **13** such that a first electrical terminal is coupled to a flange **23** of the ground plane **16** by a solder bead **22** while the other electrical terminal of the chip capacitor **20** is electrically coupled to the outerdiametric surface of the eyelet **41** by a solder bead **44**.

Referring next to FIG. **7**, a partial cross-sectional portion of a second alternate embodiment of a multiple pin connector in accordance with the present invention is indicated generally at **50**. In common with the preferred embodiment, the multiple pin connector **50** is constructed such that a plurality of pins **12** are positioned to extend through holes formed through a pin-support body **11**, a filter block **51**, a ground plane **16** and a dielectric retaining block **17**. The filter block **51** utilized in forming the multiple pin connector **50** differs from the filter block **13**, described and illustrated with respect to FIGS. **2** and **5**, in that the holes therethrough accepting the pins **12** are constrained to have an internal diameter substantially equal to the diameter of the pins **12**. Thus, each pin **12** is in frictional contact with the dielectric material forming each of the pin-support body **11**, the filter block **51**, and the dielectric retaining block **17**. Each pin **12** has a recess **27** associated therewith, as is described with respect to the preferred embodiment. A chip capacitor **20** is placed within each recess **27** such that a first electrical terminal of the chip capacitor **20** is in direct physical contact with a flange **23** of the ground plane **16** while the other electrical terminal of the chip capacitor **20** is in direct physical contact with a surface of the pin **12** passing through the associated hole. Referring briefly to FIG. **3**, it may be observed that the flanges **23** formed on the ground plane **16** are bent with respect to the web **32** such that angles of less than ninety degrees are formed between the web **32** and each of the flanges **23**. Referring again to FIG. **7**, the chip capacitor **20** is held in position by a spring action of the flange **23**, acting as a result of its degree of bending to an acute angle, to produce forces acting on the chip capacitor **20**. In assembly of the multiple pin connector **50**, the pin **12** is first appropriately inserted through its hole in the filter block **51** and the ground plane **16**, then the flange **23** is bent downwardly of FIG. **7** so that the chip capacitor **20** may be placed between the inner surface of the flange **23** and the pin **12**. When the flange **23** of the ground plane **16** is released, the flange assumes its illustrated acute angle position, thereby producing the forces retaining the chip capacitor within the recess **27** and in the appropriate electrical contact between the pin **12** and the flange **23**.

While the invention has been particularly described in reference to a preferred embodiment and two alternate embodiments thereof, it will be understood by those skilled in the art that changes in form and detail may be made without departing from the spirit and scope of the invention. For example, this disclosure shows a twenty-five pin connector, however, any number of pins may be used and in any configuration or size which may be desired to mate with other plug-and-socket designs.

I claim:

1. An electrical connector assembly comprising:

a plurality of pins,

a ground plane, said ground plane provided with a plurality of cavities corresponding in number to said plurality of pins, each of said cavities circumferentially surrounding a corresponding one of said pins,

a plurality of filter elements, each of said filter elements being in non-circumferential relationship with an associated pin, each of said filter elements having a first electrical terminal and a second electrical terminal,

said first electrical terminal of each one of said filter elements being in electrical contact with an associated pin, and

said second electrical terminal of each one of said filter elements being in electrical contact with a common surface of said ground plane.

2. A device as in claim **1** wherein the longitudinal axes of said pins are substantially in alignment and said common surface of said ground plane is substantially parallel to said axes.

3. A device as in claim **2** wherein said common surface is biased toward said pins,

whereby said filter elements are retained in position by said biasing.

4. A device as in claim **1** further comprising:

a filter block provided with a plurality of cavities corresponding in number to said plurality of pins, each one of said filter block cavities circumferentially surrounding one of said pins.

5. A device as in claim **4** wherein said filter block includes:

a plurality of recesses, each one of said recesses being associated with a corresponding filter block cavity, said recesses being configured to accept one of said filter elements.

6. A device as in claim **1** further comprising:

a substantially cylindrical conductive eyelet interposed between at least one of said pins and a corresponding filter element,

the outer circumference of said eyelet being in electrical contact with said first terminal of said filter element, and

the inner circumferential surface of said eyelet being in electrical contact with said pin.

7. An electrical connector assembly comprising:

a plurality of pins,

a ground plane provided with a plurality of cavities corresponding in number to said plurality of pins, each one of said cavities circumferentially surrounding the corresponding one of said pins, said ground plane having at least one electrically conductive substantially planar surface,

a plurality of filter elements, each of said filter elements being in non-circumferential relationship with an associated pin, each one of said filter elements having a first electrical terminal and a second electrical terminal,

each one of said filter elements having said first electrical terminal in electrical contact with an associated one of said pins, said second terminal of each of said filter elements being in electrical contact with said electrically conductive substantially planar surface.

8. An electric connector assembly comprising:

a plurality of pins;

a ground element having a corresponding plurality of apertures, each of said apertures associated with one of said pins; and

a filter element associated with at least one of said pins, said filter element being in non-circumferential relationship with said associated pin, said filter element having a first exterior edge electrically contacting said associated pin and a second exterior edge electrically contacting said ground element.

9. A device as in claim 8 wherein said filter element is positioned between said associated pin and at least a portion of said ground element.

* * * * *